



The Integrated Natural Environment - Authoritative Representation Process (INE-ARP)

*The Program, Architecture, and
Technologies*

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SAIC**



Outline

★ **Programmatic Overview**

- DMSO INE Program
- INEARP Team
- Funding History

★ **INEARP Overview**

- Reference Model
- Technology Components (high-level)
- Development Strategy

★ **Technology Review**

- ESG in more detail
- Related capabilities
- INEARP Concepts

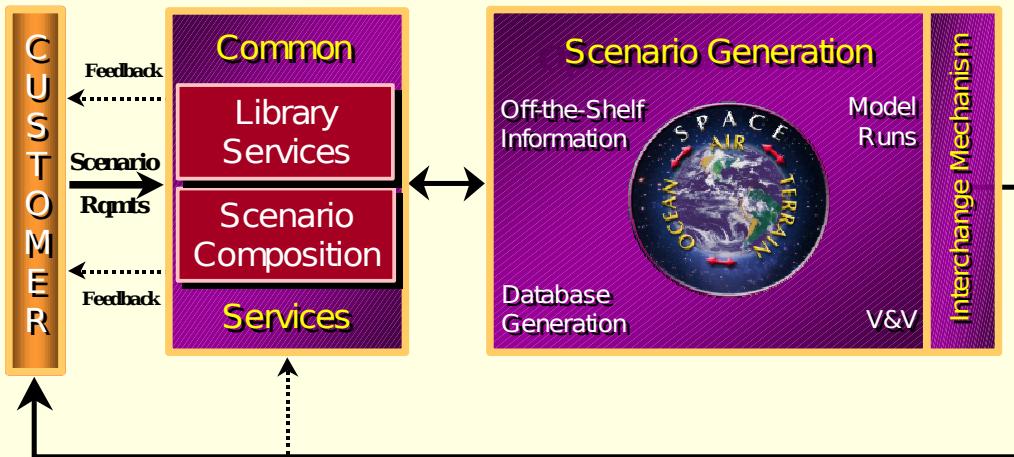
★ **Collaboration**



DMSO Integrated Natural Environment (INE) Program

Requirements

Scenario-driven physically consistent, cross-domain authoritative representations of the natural environment



Goals

Readily accessible infrastructure for obtaining authoritative environmental representations

Robust capability to cost effectively acquire required environmental scenarios

Quality product and timely delivery

Environmental Common Services

Environmental Requirements/Interchange Environment Integration

Develop enabling technologies to support scenario composition & generation, library services and database generation functions.

INE-ARP Integrated Technology Development In FY-02

Develop enabling technologies to support specification of data requirements and data models for all environmental domains as well as standard interchange mechanisms.

Ocean and Atmosphere Common Data Model

Synthetic Environment Data Representation and Interchange Specification

Test and demonstrate the enabling technologies and their implementation as an end-to-end prototype of the Integrated Natural Environment Authoritative Representation Prototype

Integration Experiment

Environment Federation

Warfighter Experiments



Modeling and Simulation Executive Agents for Terrain, Ocean and Atmosphere and Space

Partners with DMSO in development and implementation of the Authoritative Representation Process (INE-ARP). Serving as focal point for integrating Service and Agency

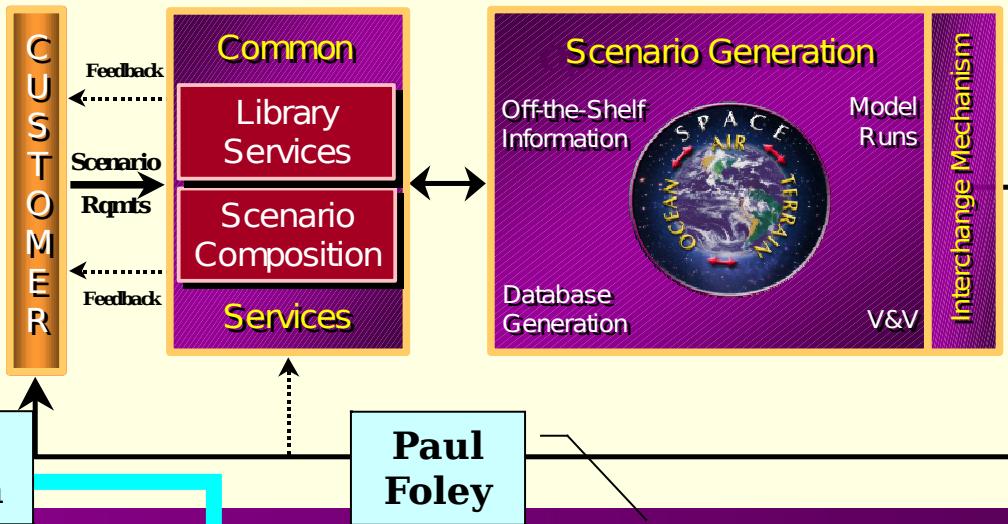
DMSO

Integrated Natural Environment (INE) Program



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Quality product and delivery

John
Hugh

Paul
Foley

Bob
Lutz

Environmental Common Services

Develop enabling technologies to support scenario composition & generation, library database generation

SAIC

Environmental Library

SAIC

Environmental Scenario

Terrain Scenario Generation

LMIS

Planning

Develop enabling technologies to support specification of data requirements and data models for all environmental domains as well as standard interchange mechanisms.

LMIS

Land Atmosphere Common Data Model

SAIC

Geographic Environment Data Interchange Specification

Test and demonstrate the enabling technologies and their implementation as an end-to-end prototype of the Integrated Natural Environment Authoritative Representation

ANL

APL

TASC

IDA

Integration Experiment

Environment Federation

Flight Experiments

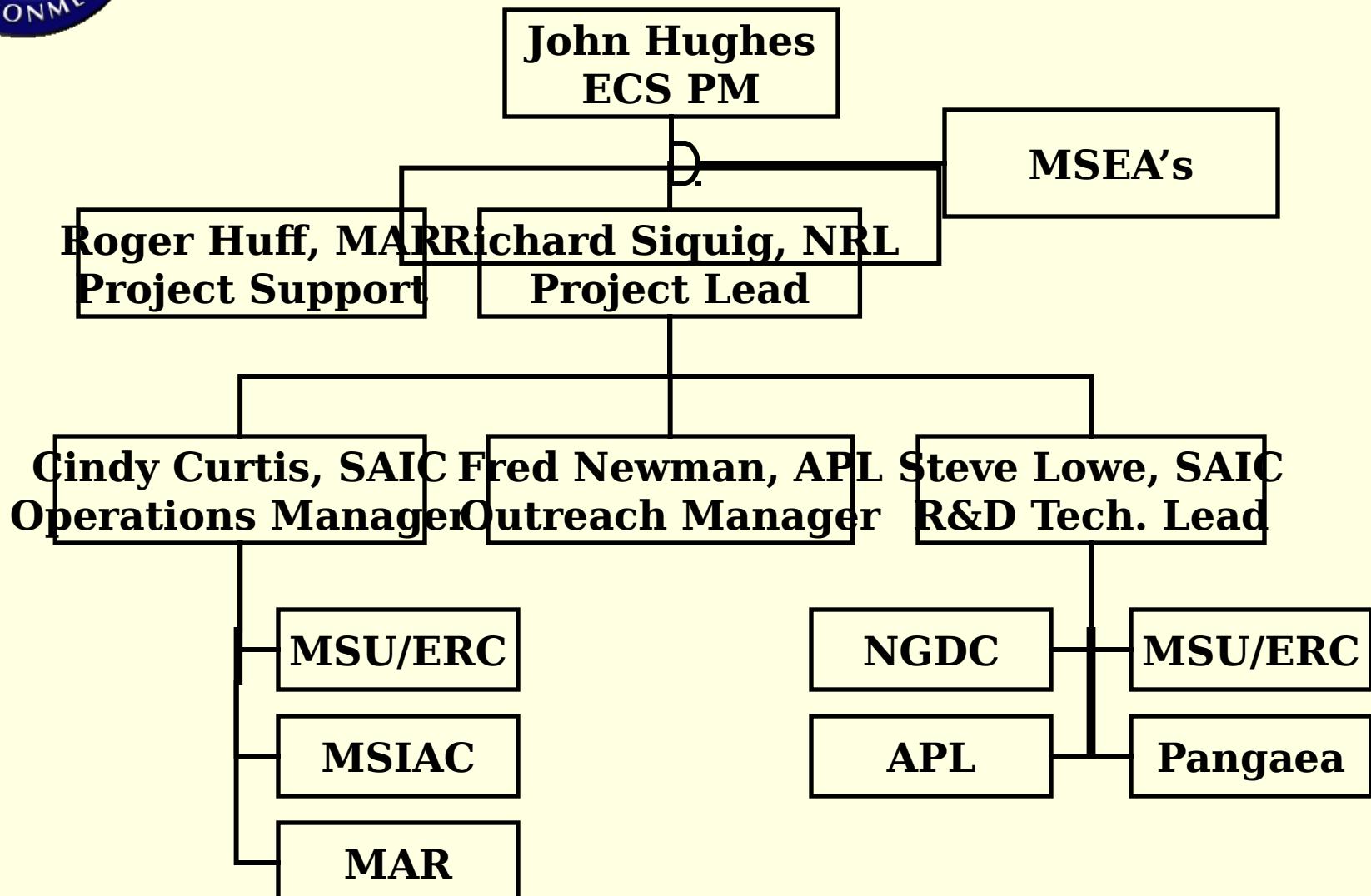


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Modeling and Simulation Executive Agents for Terrain, Ocean and Atmosphere and Space



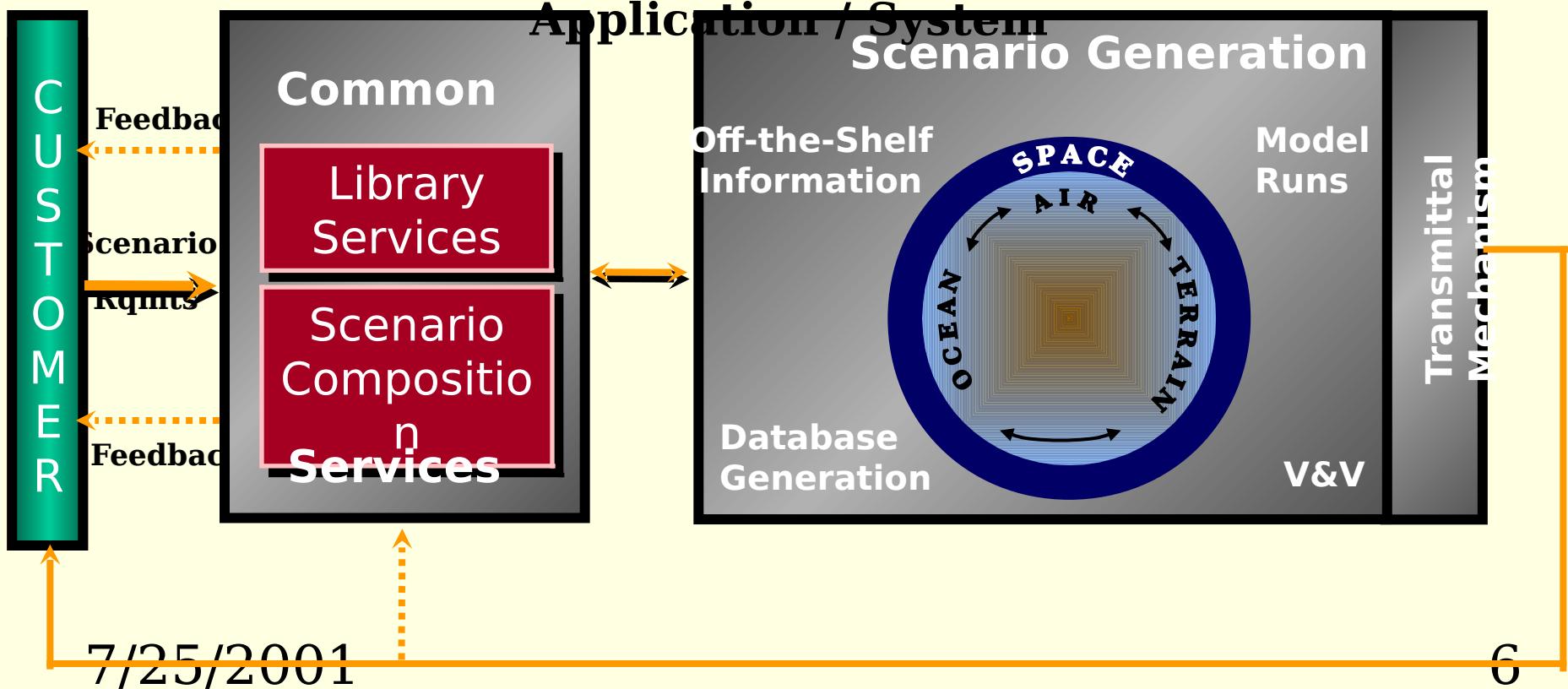
INE ARP Project Organization





INE-ARP CONOPS

Create an *Appropriate* Natural Environment Representation that is *Physically Consistent*, both within and among the Atmosphere, Ocean, Space, and Terrain Domains, for *Timely and Cost Effective* Delivery to a Customer





Master Environmental Library (MEL)

<http://mel.dmso.mil>

- ★ **Geospatial data products registered using FGDC metadata**
- ★ **Integrated Query and Browse capabilities based on FGDC metadata elements, common terminology, and thesauri**
- ★ **Custom / Flexible Ordering services that provide automated access to registered data resources**
- ★ **The MEL is a fully operational system with a staffed central site and a network of managed resource sites.**



Environmental Scenario Generator (ESG)

<http://esg.ngdc.noaa.gov/esg>

- ★ Provides an “intelligent search” capability to seek out specific environmental events from reference data resources.
- ★ Provides an architecture for generating custom environmental data bases from distributed data and modeling resources
- ★ Translation of M&S Customer Requirements into environmental requirements is under development.
- ★ Though not “released”, excellent track-record of real support
 - JWARS, JMASS, Sample provided to JSIMS
 - NWC/GLOBAL-99,-00,-01, JTASC, SMC, DMSO’s EnviroFed



Terrain Scenario Generation and Archiving (TSG&A)

★ Terrain Scenario

- The authoritative representation of the terrain for the purposes M&S Training, Analysis & Acquisition
- Component of an Integrated Natural Environment (INE) Scenario

★ Generation

- Use of authoritative terrain data sources (e.g., NIMA)
 - Leverages DoD Geospatial Information Infrastructure (GII)
- Development of wide-use terrain data set generation technology
 - Leverages & integrates DARPA, ERDC/TEC and STRICOM work
 - Use of COTS (e.g., GIS, TIN tools) and GOTS (e.g., SEDRIS) technology
 - Focus on production of artifact-minimized integrated terrain data sets
- **Integrated within the INE Authoritative Representation Process**
 - Addresses terrain portions of the MSEA INE Strategy

★ and Archiving

- Development of wide-area wide-use terrain scenarios
 - Target: unrestricted access, on a worldwide basis
 - Based on a well-known data model (eventually standard)
- MEL-accessible and SEDRIS-available



Synthetic Environment Data Representation and Interchange Specification (SEDRIS)

<http://sedris.org>

★ **SEDRIS Representational Technologies**

- Data Representation Model (DRM)
- Environmental Data Coding Specification (EDCS)
- Spatial Reference Model (SRM)
- Software Interface Specification (API's)
- SEDRIS Transmittal Format (STF)

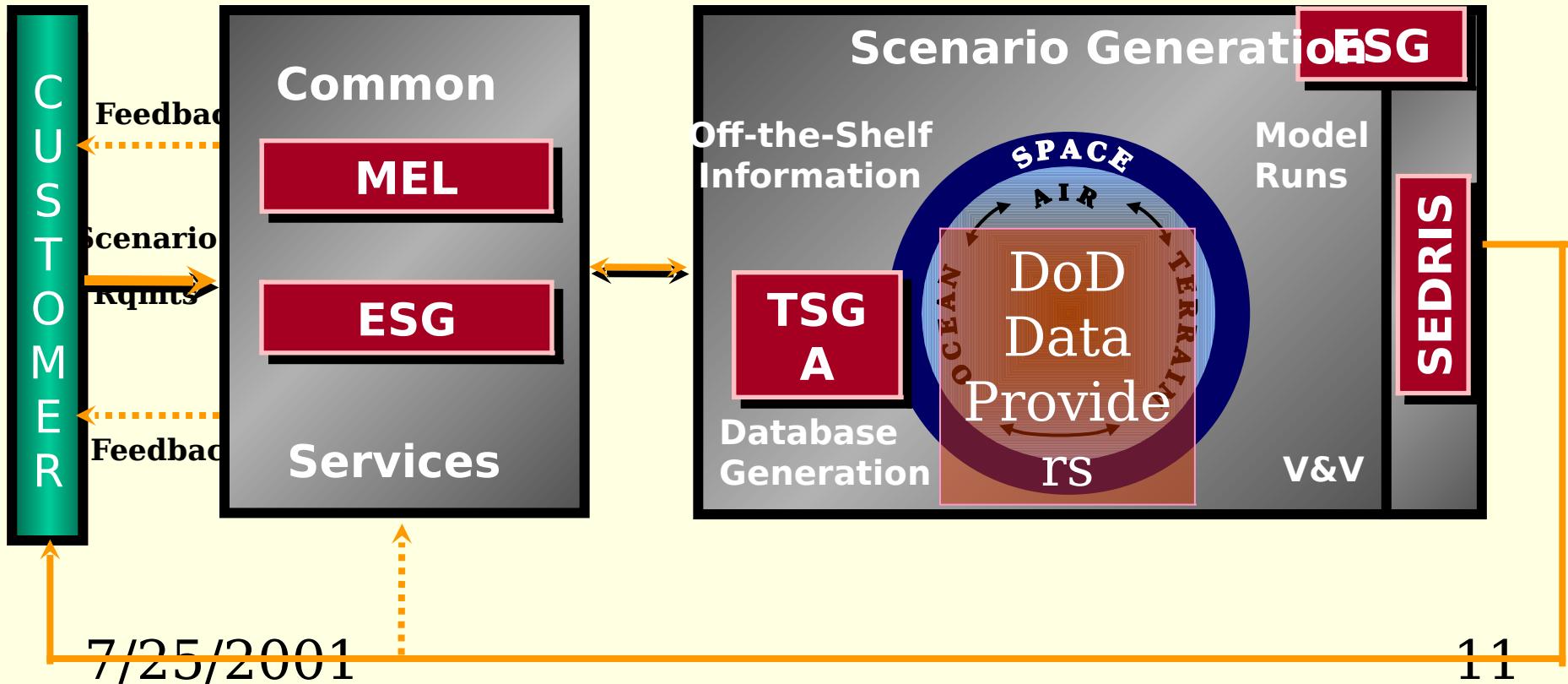
★ **SEDRIS Applications and Utilities**

- COTS/GOTS value-adding tools based on the representation of environmental data in SEDRIS data objects (via API or populated from STF).



INE-ARP “as-built” Today

- ★ MEL, ESG, TSGA, and SEDRIS provide the technology pieces
- ★ MEL Resource Sites and some prototype model and service providers
- ★ Demonstrated ability to support M&S Exercises





Motivations for Re-Architecting

- ★ **The complete INE-ARP Vision was created after the technology pieces**
- ★ **MEL Architecture too tightly wrapped around FGDC metadata and focused only on data resources**
- ★ **ESG developed as a prototype application**
 - MEL Query/Browse functionality not well integrated
 - Advanced services are managed independent of MEL resources
- ★ **SEDRIS used for transmittal format only**
 - ESG/MEL do not fully leverage the SEDRIS technologies
- ★ **Desire to support application development**

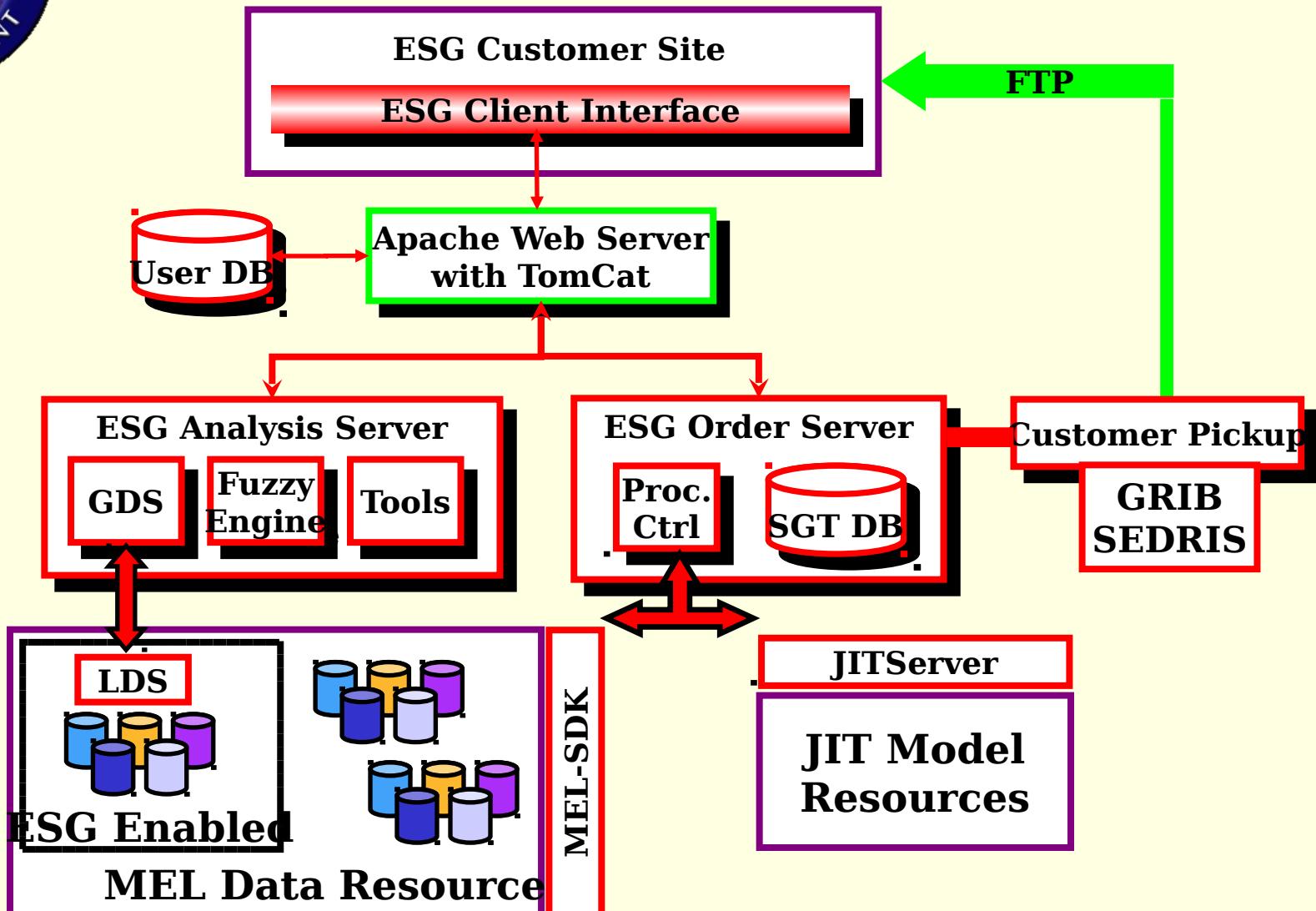


INE-ARP Development Strategy

- ★ **Implement an INE-ARP infrastructure providing**
 - Metadata management for data, models, and transforms
 - “Query” and “Browse” services for all resource types
 - Multiple levels of data access (from MEL-like to ESG-like)
 - Application/Execution of sequences of models and transforms
- ★ **Fully leverage SEDRIS Technology**
 - EDCS for terminology
 - Internal use of DRM for structure of data containers (?)
 - SRM for spatial representation translation (?)
- ★ **Focus on continued development of ESG to support M&S Customers**



ESG Architecture, Build 3





ESG Intelligent Data Searching

- ★ **Provides service to locate environmental events**
- ★ **Requires real-time interaction with selected data sets**
 - Java RMI based communication
- ★ **Employs Fuzzy-Logic classification techniques**
 - Assignment of weights to each 4D data point based on its proximity to desired condition
 - Aggregation of weights across time, space, parameter
 - Can be applied to any geospatial data set
 - Does not modify data in any way

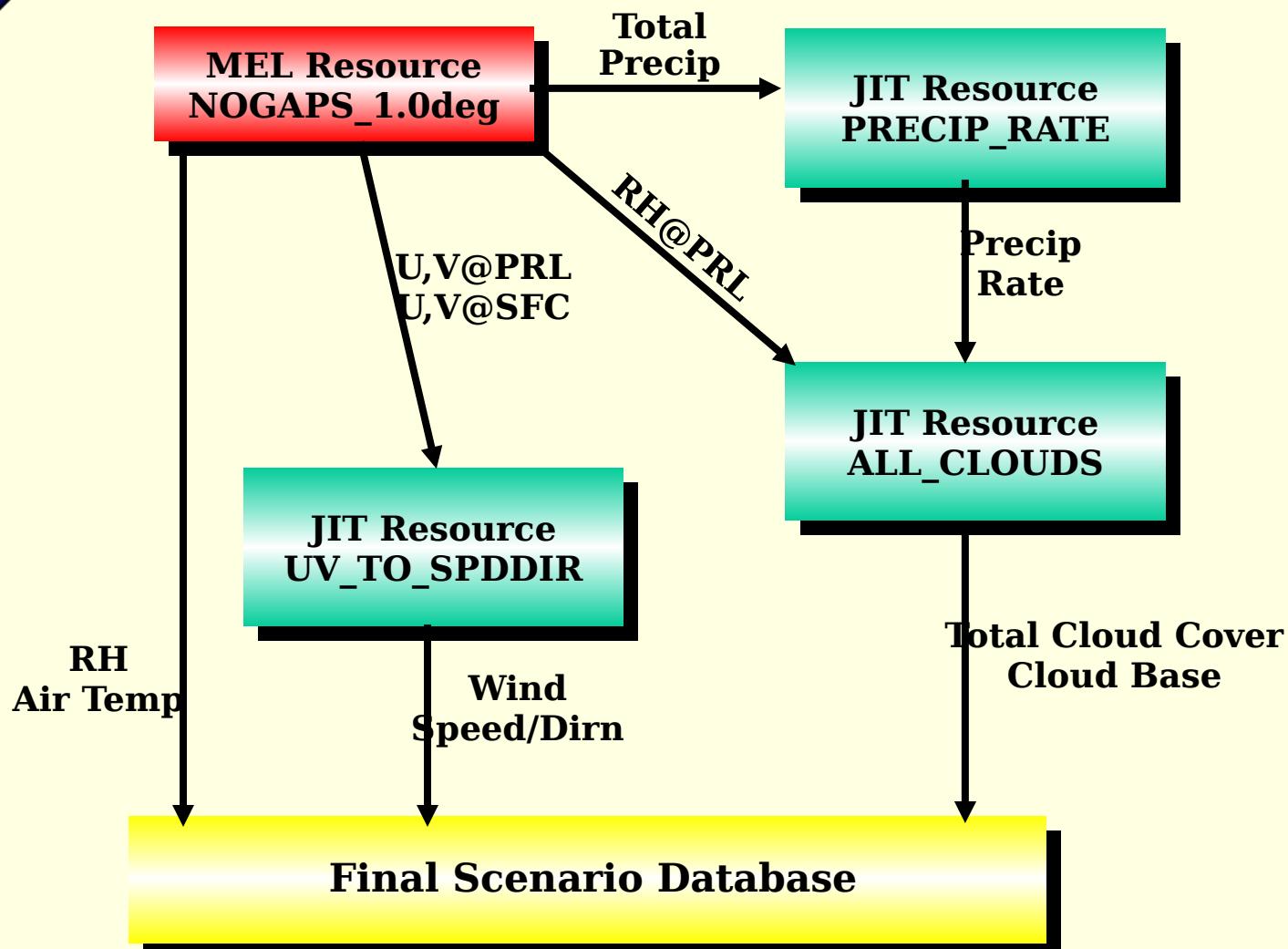


Scenario Generation Template

- ★ **Allows for User definition, validation, and acceptance of the scenario generation process**
- ★ **Provides for a robust and repeatable process**
- ★ **XML based**
- ★ **Specification of:**
 - Data and Model Resources (process dependencies)
 - Final set of output parameters desired
 - Spatial and Temporal Domains
- ★ **SGT Metadata Description**
 - User Access Control
 - Links to metadata for data and model resources employed



Sample SGT “Data Network”

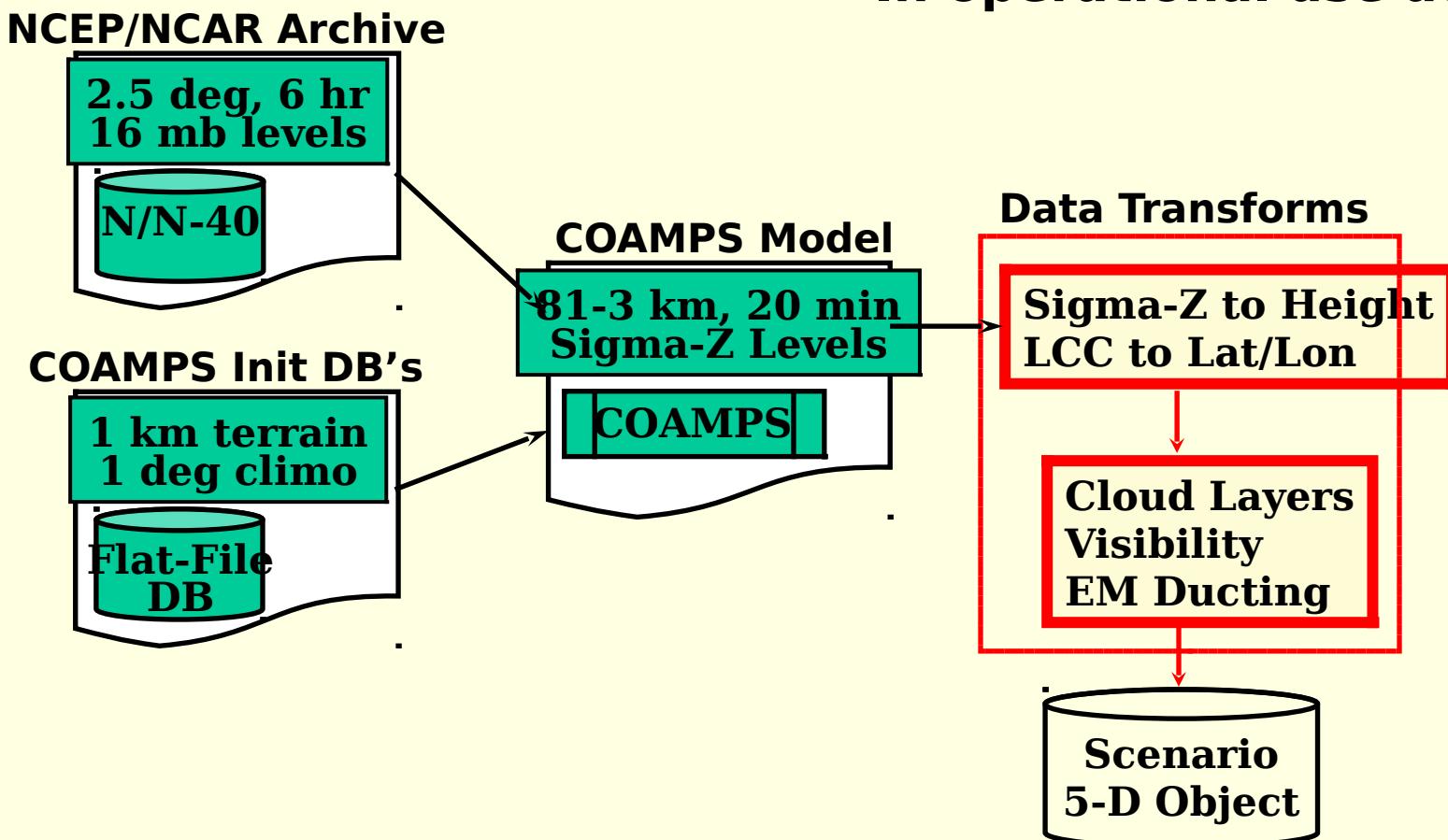




ESG Prototype JIT Model - COAMPS

Coupled Ocean/Atmosphere Mesoscale Prediction System

- NRL Developed
- In operational use at FNMO





ESG Build 3 Capability

Released June '01

- ★ **Configurable Web-Based Client Interface**
 - User Authentication and Sessions
 - Configurable terminology based on EDCS as standard
- ★ **Prototype Intelligent Search Mechanism**
 - Atmosphere, Ocean, Space domains
 - Support for multi-database (domain) queries
 - Integrated Data Analysis and Visualization
 - Definition of event sequences - "scenario segments"
 - Proof-of-Concept GIS demo (atmos + terrain)
- ★ **Prototype Just-in-Time Production**
 - Atmosphere (COAMPS + transforms)
 - Space (PIM, IonScint)
 - Ocean (WAM + transforms)
 - Order Tracking with email notification
 - Manual GRIB-to-SEDRIS translation



CY-01 Development Activity

- ★ **Formal system design process for INEARP CONOPS focused on ESG application and new infrastructure**
 - Published system design with interfaces by Jan. '02
- ★ **Rapid prototyping of key infrastructure components**
 - Metadata Management
 - J2EE component based architecture for access to resources
- ★ **Continued development of ESG through incremental builds**
 - First official ESG Release Candidate by Jan. '02
 - ESG will fully leverage new infrastructure for resource access
- ★ **Additional Activity**
 - MEL 3.x continues to live and breath through CY-01
 - ESG will continue to provide customer support
 - JWARS, JMASS, EFIII, GLOBAL-01, etc.



ESG RC-1.0 Capability

March, '02 Release

★ **Resource Additions**

- Inclusion of ACMES and TSGA resource sites
- Transition of ESG and select MEL resource sites to INE Resources
- Capability for atmos-terrain coupling
- Capability for Perceived Truth database generation

★ **ESG Feature Additions**

- Integrated (Met, Ocean, Terrain) data sets in STF
- Virtual Data Mart
- Scenario Review Capability
- Full integration of GIS Capabilities in ESG Interface

★ **Customer Interaction Applications**

- Customer Requirements / Terminology Mapping
- Determination of Authoritative Representation
- Construct Scenario Generation Templates



INE Resource Providers, CY-01

- ★ **AF Combat Climatology Center (AFCCC) / ASNE**
 - ACMES 10-Year 40 km regional atmospheric data archives
 - JIT implementation of ACMES modeling capability
- ★ **Prototype TSGA Site**
 - TSGA Feature and DEM products
 - TSGA transforms (areal to grid)
- ★ **Naval Research Laboratory (NRL), Monterey**
 - 3+ year archive of FNMOC METOC model products
- ★ **DMSO Sponsored Prototype Resources**
 - 20 Years of NCEP/NCAR Re-Analysis
 - 18 month environmental scenario databases (Korea / SWASIA)
 - COAMPS and WAM models
 - Suite of atmospheric and oceanic environmental transforms
 - NGDC Space Weather archives and PIM/IonScint models



INE ARP Technologies and Concepts



INE-ARP Resource Definitions

- ★ Data Resources
 - **No input requirements to obtain**
 - **Does NOT imply ready or free access**
- ★ Model Resources
 - **Produces data resources (which may or may not be archived)**
 - **Structured data input requirements for execution**
 - **Only certified for use with specific data / model resources**
- ★ Transform Resources
 - **Applies a service to data**
 - **General usage - limited restrictions based on type / format**
 - **Examples:**
 - **Data Representation Changes (vectors areals to grid)**
 - **Format Changes (grib to sedris)**
 - **Derived Parameters (compute RH from T, P, Q)**



INE-ARP Key Concepts

As defined by Ron Haynes, ASCE

★ **Authoritative Representation (AR)**

- Objectively: The environmental representation at which the addition of more resolution adds no additional significant information
- Subjectively: The resolution appropriate for the selected environmental event, capabilities of available models, and the intended application of the resulting environmental representation

★ **Ground Truth (GT)**

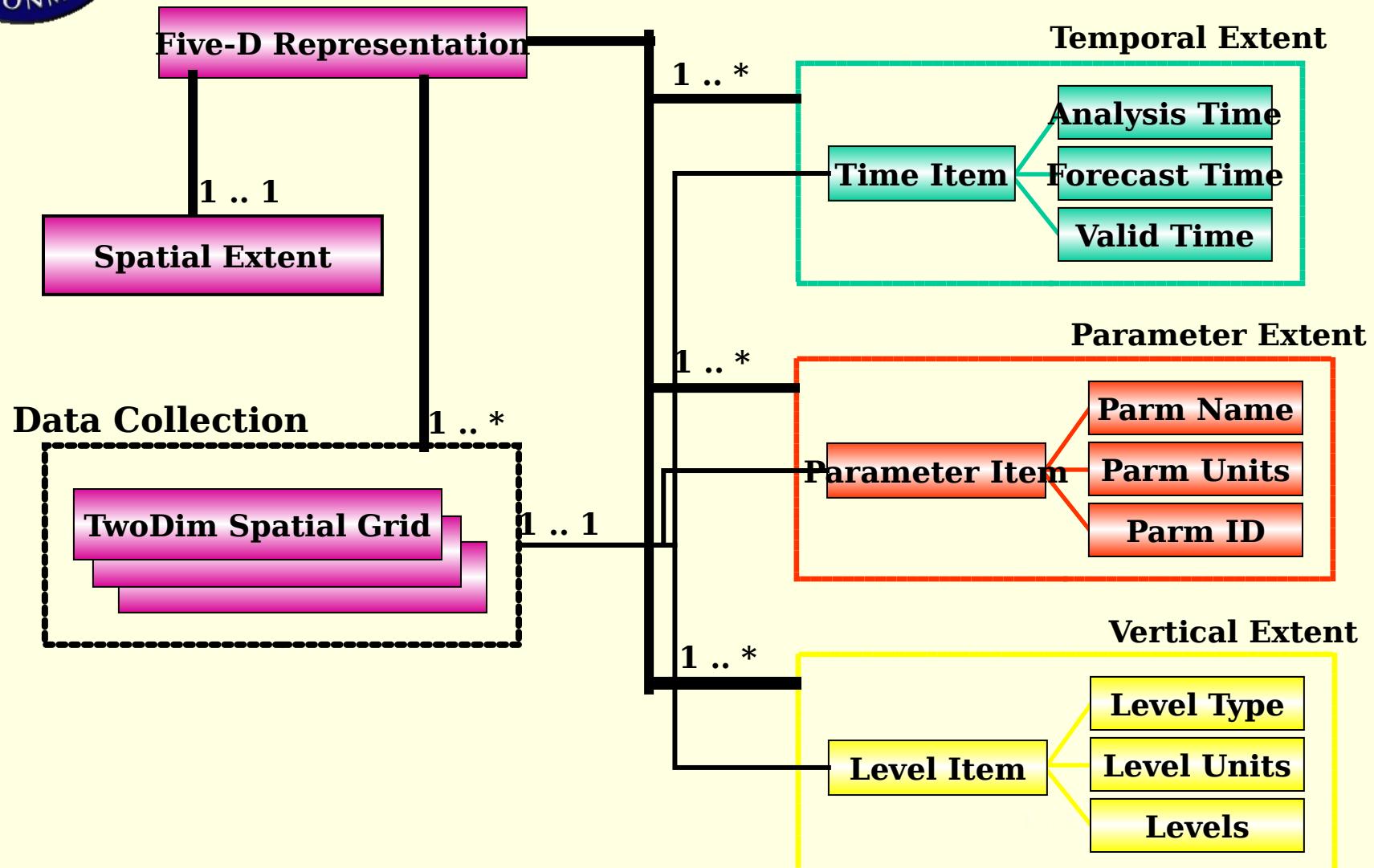
- The environmental representation defined to be the basis for reality
- $AR = F(t)$

★ **Perceived Truth (PT)**

- The environmental representation perceived by a simulated entity
- Degraded from GT due to fidelity of entity model and/or sampling
- Alternate reality used to deceive players (AKA, a forecast)



FiveDimRep Data Model





FiveDimRep Utilities

★ **Spatial Transformations**

- Re-gridding to new projections and/or sub-regions
- Multiple interpolation schemes, configured by parameter
- Efficient caching mechanism to avoid re-interpolation

★ **Temporal Transformations**

- Forecast overlap de-confliction
- Mapping to alternate reference time

★ **Full GRIB Import / Export Support**

- Parameter / Level ID Mapping
- Web-Based interactive GRIB decoder

★ **Mapping to SDRM, with support for export to STF**

★ **Visualization via VISAD**

★ **Mapping from Spatial Grids to Time Series**



FiveDimRep Expansion and Re-Model

- ★ **Strict separation of data representation from data storage**
 - Supports native DB storage and efficient caching
- ★ **Expansion to support for**
 - Profiles, Time Series, Points
 - Irregular Grids
- ★ **Tighter coupling to SDRM and use of EDCS**

- ★ **Additional Tools and Utilities**
 - Web-based interaction
 - Additional visualization linkages (SGT, DX, IDL)
 - Support for Temporal and Vertical interpolation



Questions / Comments ?

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